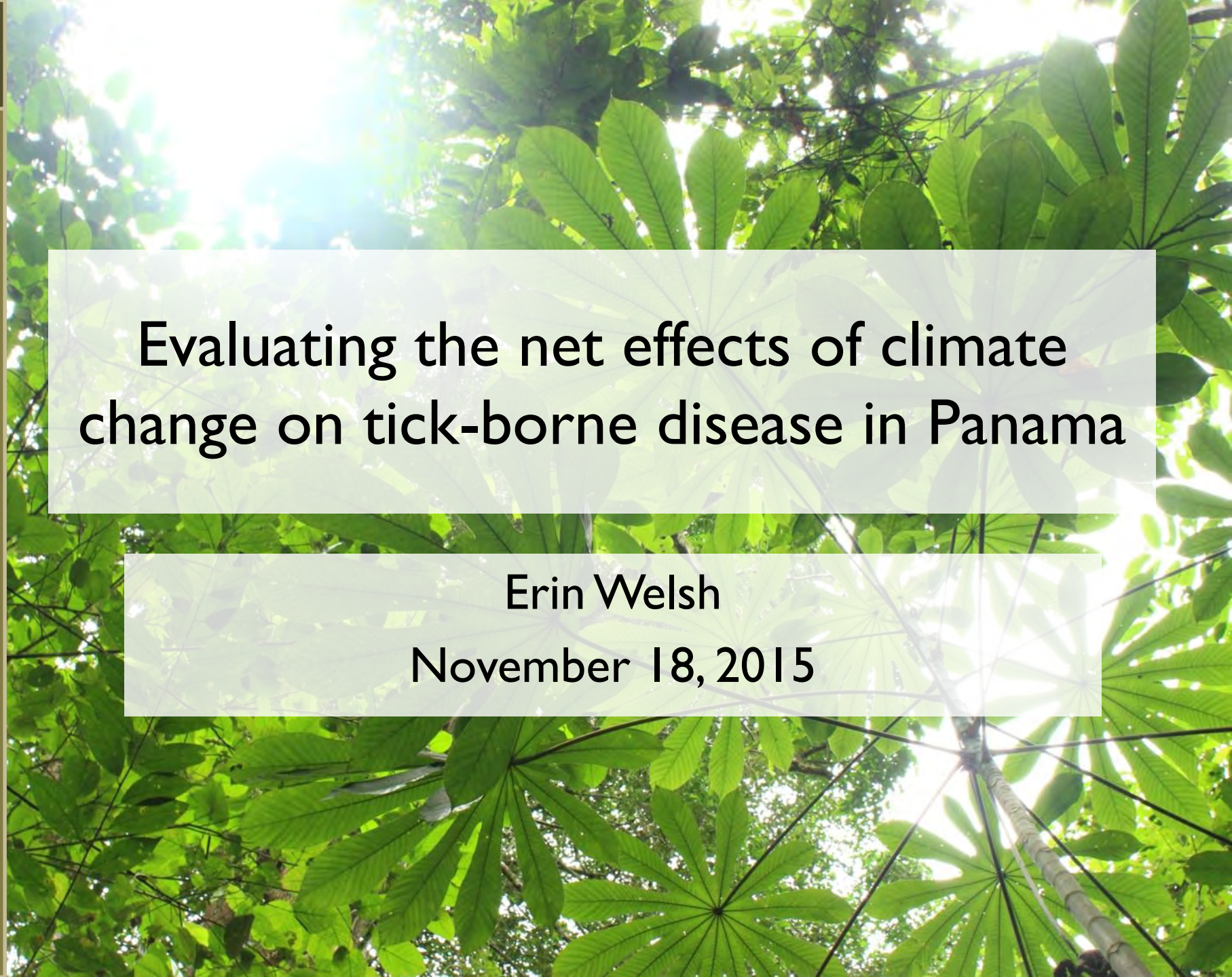


Evaluating the net effects of climate change on tick-borne disease in Panama

Erin Welsh

November 18, 2015

Climate Change & Vector-Borne Disease

- Wide-scale shifts in climate will affect vectors and the pathogens they transmit

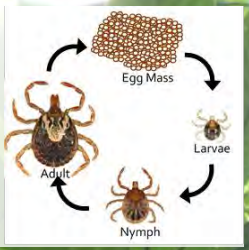
- Largest gap is the lack of knowledge of what determines current vector & pathogen distributions

Overarching goal is to characterize current biology of a vector-borne disease system and model how it's going to change

Background – Ticks in Panama

- Over 40 species of ticks in Panama
- Several tick species carry pathogens of public health importance
  - *Rickettsia rickettsii* (Spotted Fever Rickettsiosis)

Background – Tick Ecology

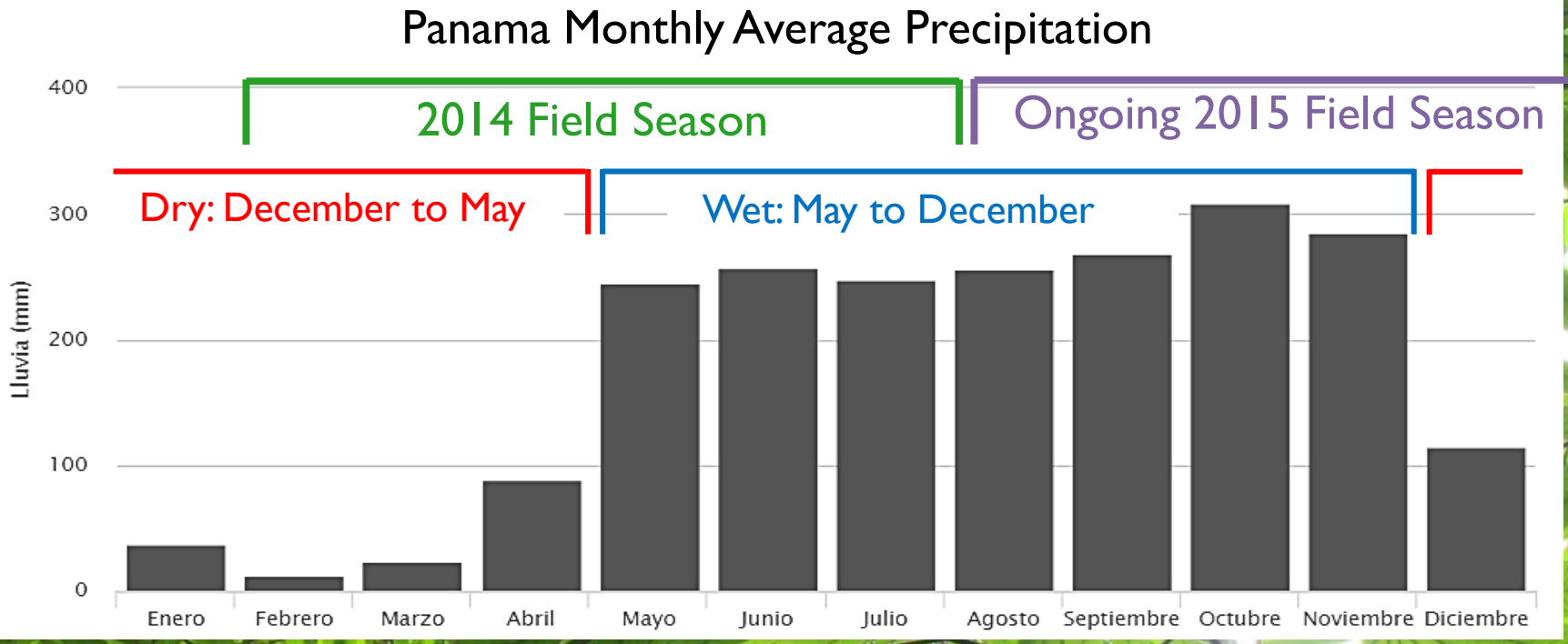


- Obligate blood-feeders with multi-stage life cycle
- Ticks spend majority of life off host (up to 98%)

Photo courtesy of K. Bartowitz

- Off-host mortality is caused primarily by:
  - Desiccation (temperature, humidity, life stage)
  - Pathogenic fungi

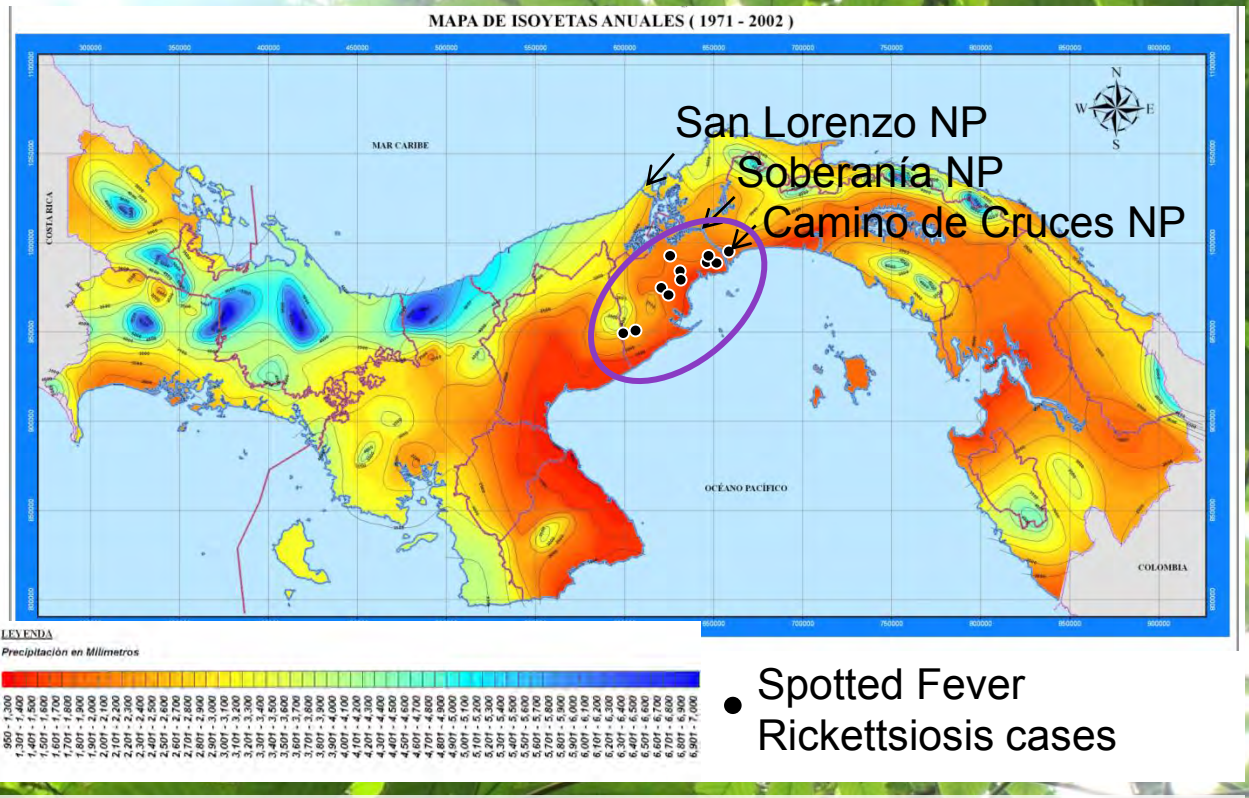
Background



Adapted from http://www.hidromet.com.pa/clima_historicos.php?sensor=2

- Climate change in Panama:
  - Overall reduced precipitation, though specific predictions vary

Precipitation Gradient – A Proxy for Future Climate Change



- Spotted Fever Rickettsiosis cases

Study Site	**Annual Precipitation**
San Lorenzo NP	3200mm
Soberanía NP	2500mm
Camino de Cruces NP	1900mm

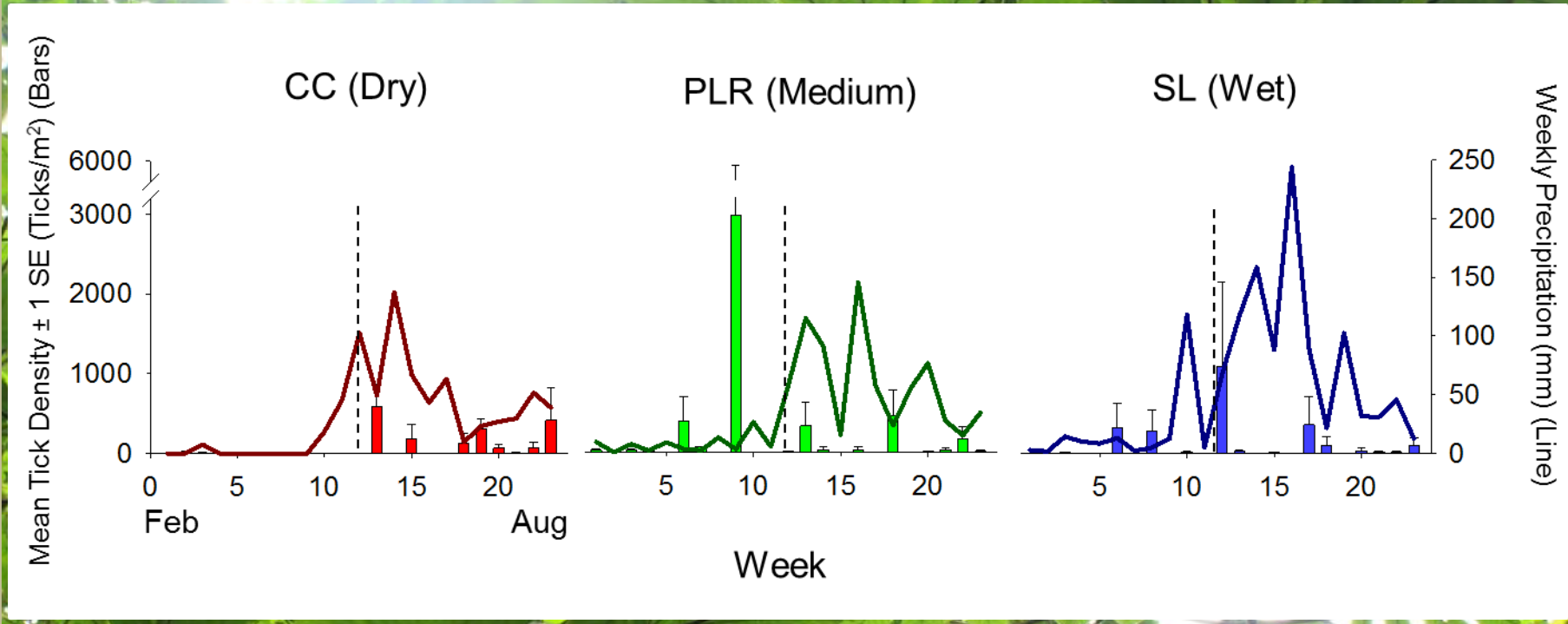
Research Questions

- What are the relative contributions of certain abiotic and biotic factors in determining tick and pathogen distributions in Panama?
  - Abiotic: temperature, humidity, rainfall, vapor pressure deficit
  - Biotic: terrestrial vertebrate abundance
- How may climate change impact future tick distributions and tick-borne disease risk in Panama?

Methods

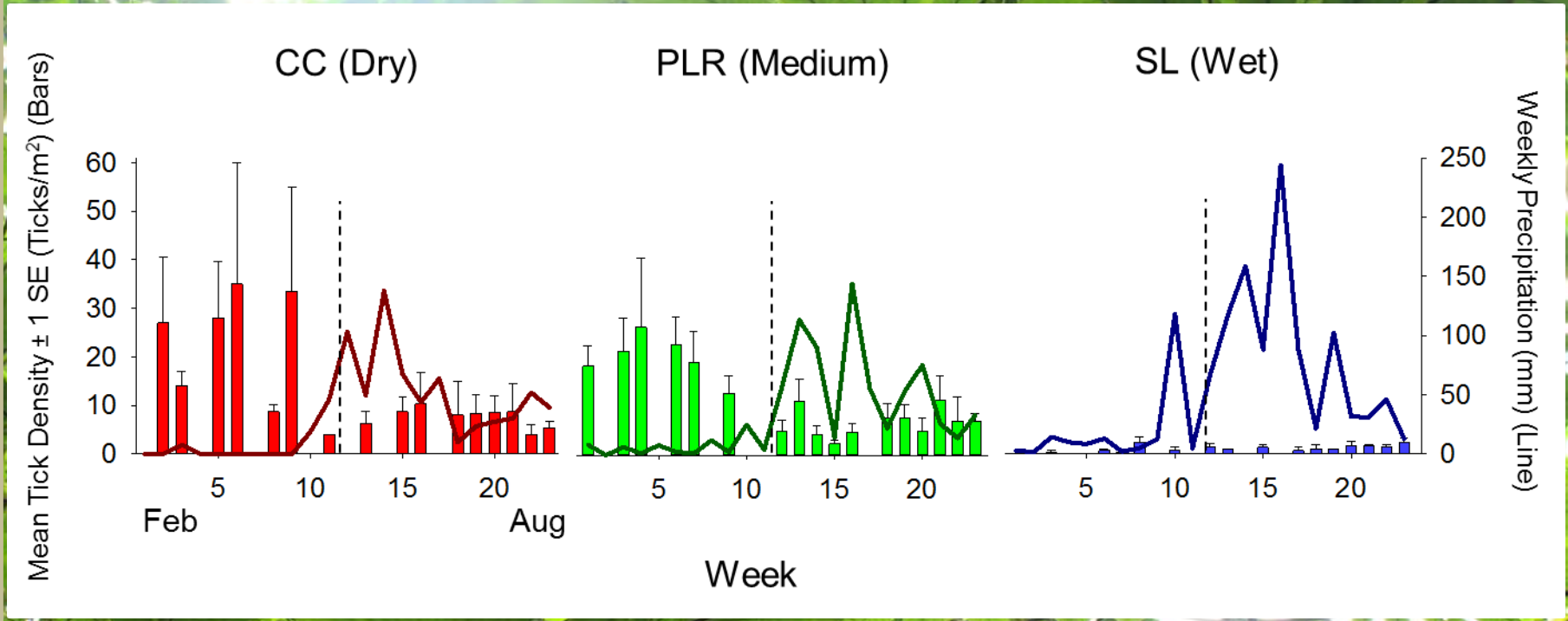
1. Drag sampling
   - Measure relative abundance of ticks
     - Overall abundance, life stage, species diversity
   - Sampled weekly at each site
2. Survival enclosures
   - Nymphs and adults placed in mesh bags
3. Camera traps
4. Pathogen screening

Seasonal Abundance Results - Larvae



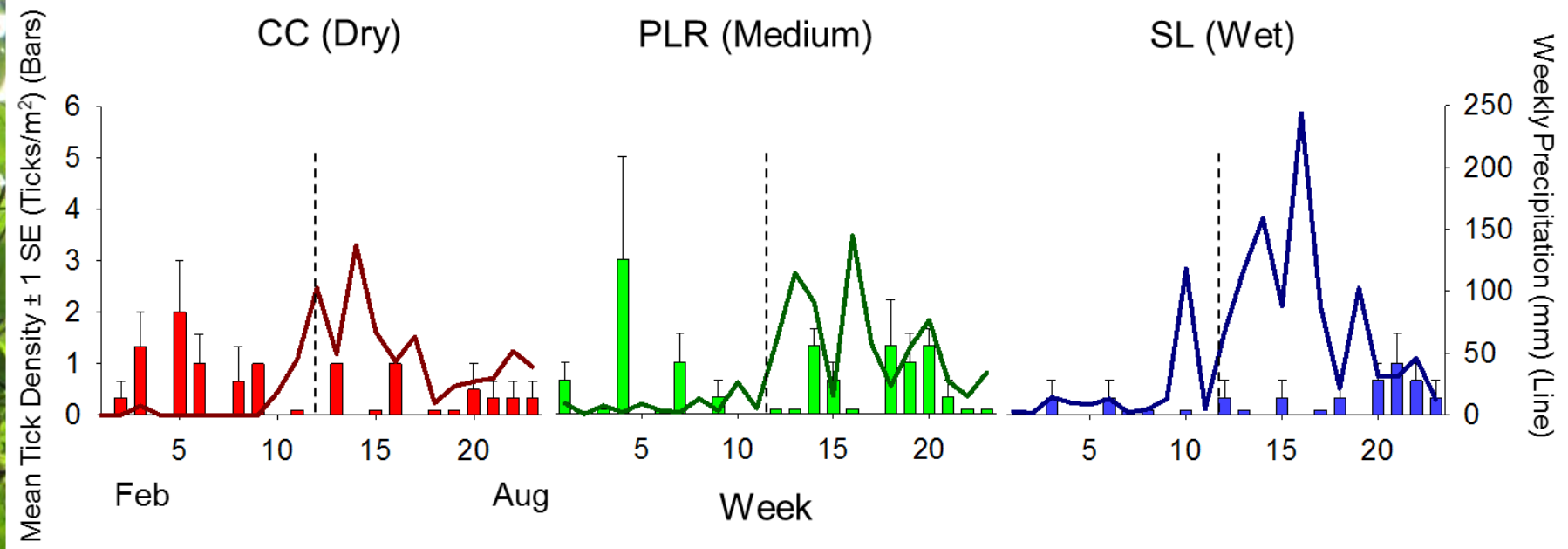
Tick density not associated with average weekly rainfall, p=0.3544

Seasonal Abundance Results - Nymphs



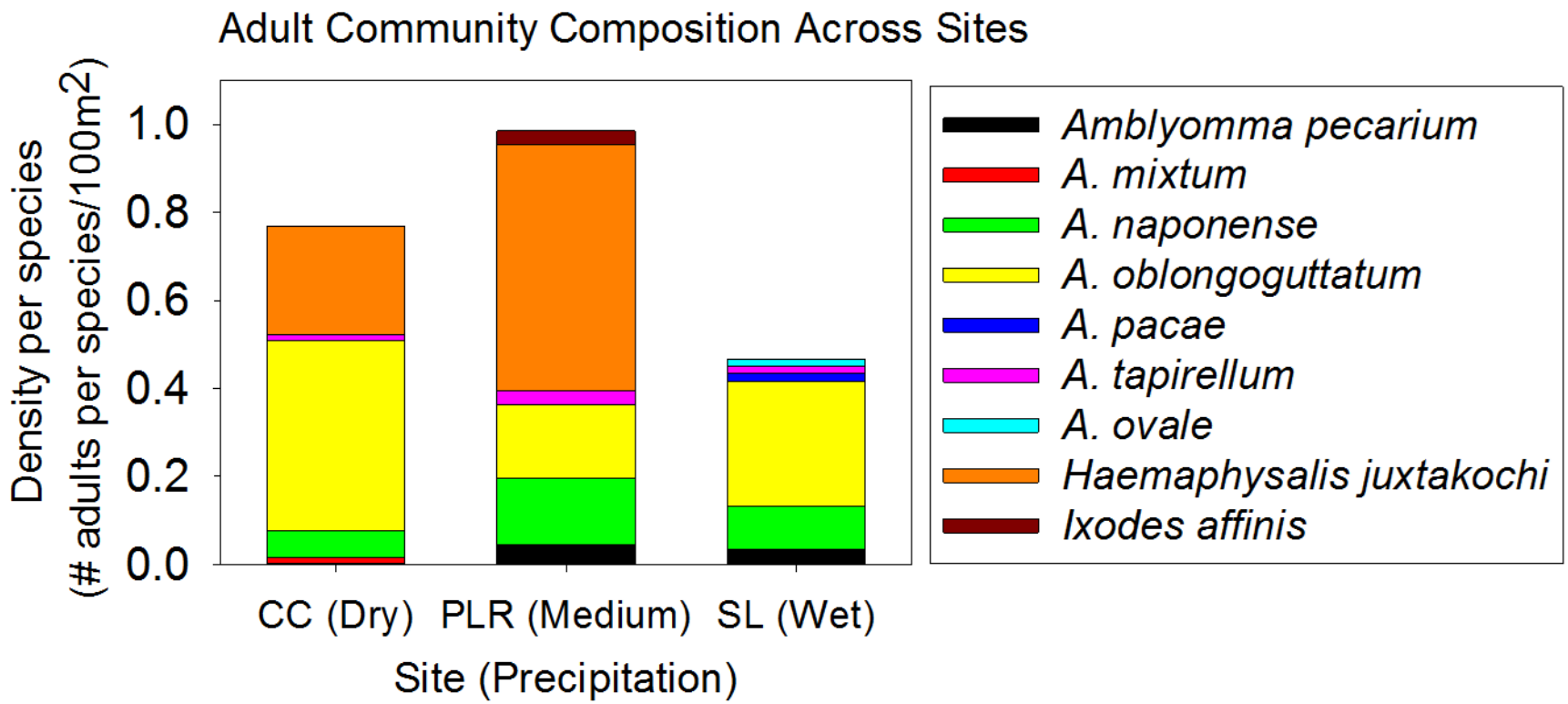
Tick density negatively associated with average weekly rainfall, $p<0.0001$

Seasonal Abundance Results - Adults

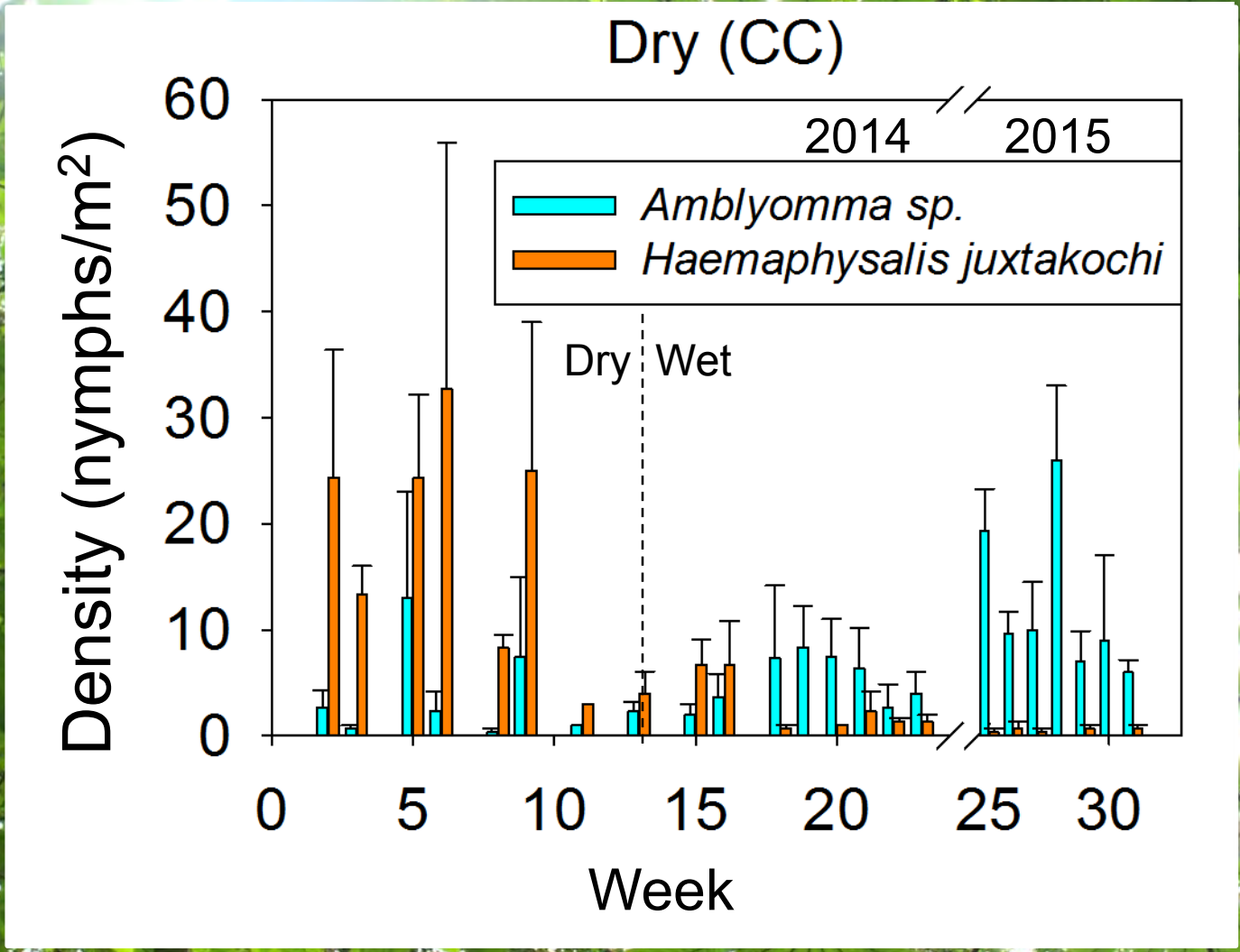


Tick density negatively associated with average weekly rainfall, p=0.003

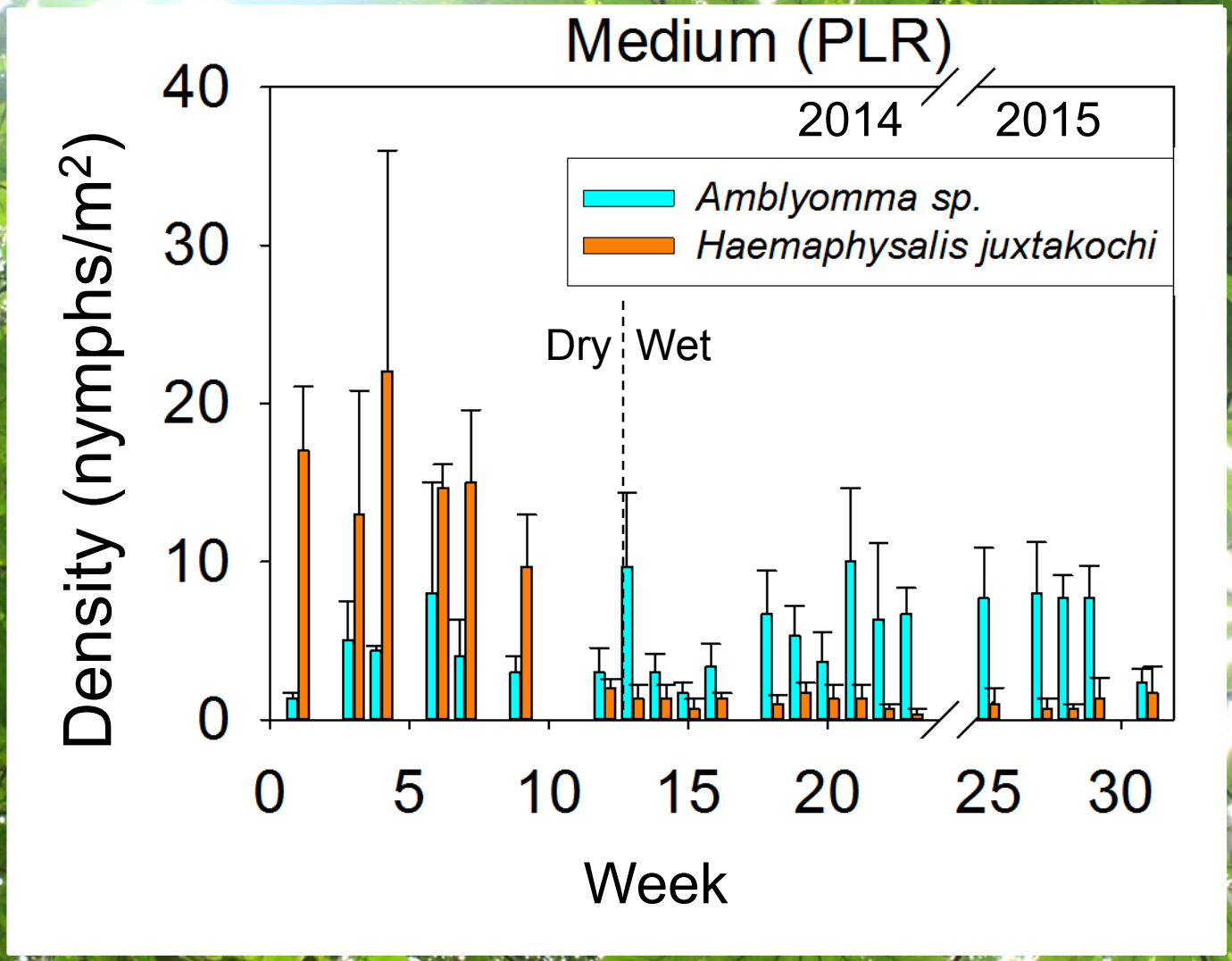
Species Composition Across Sites



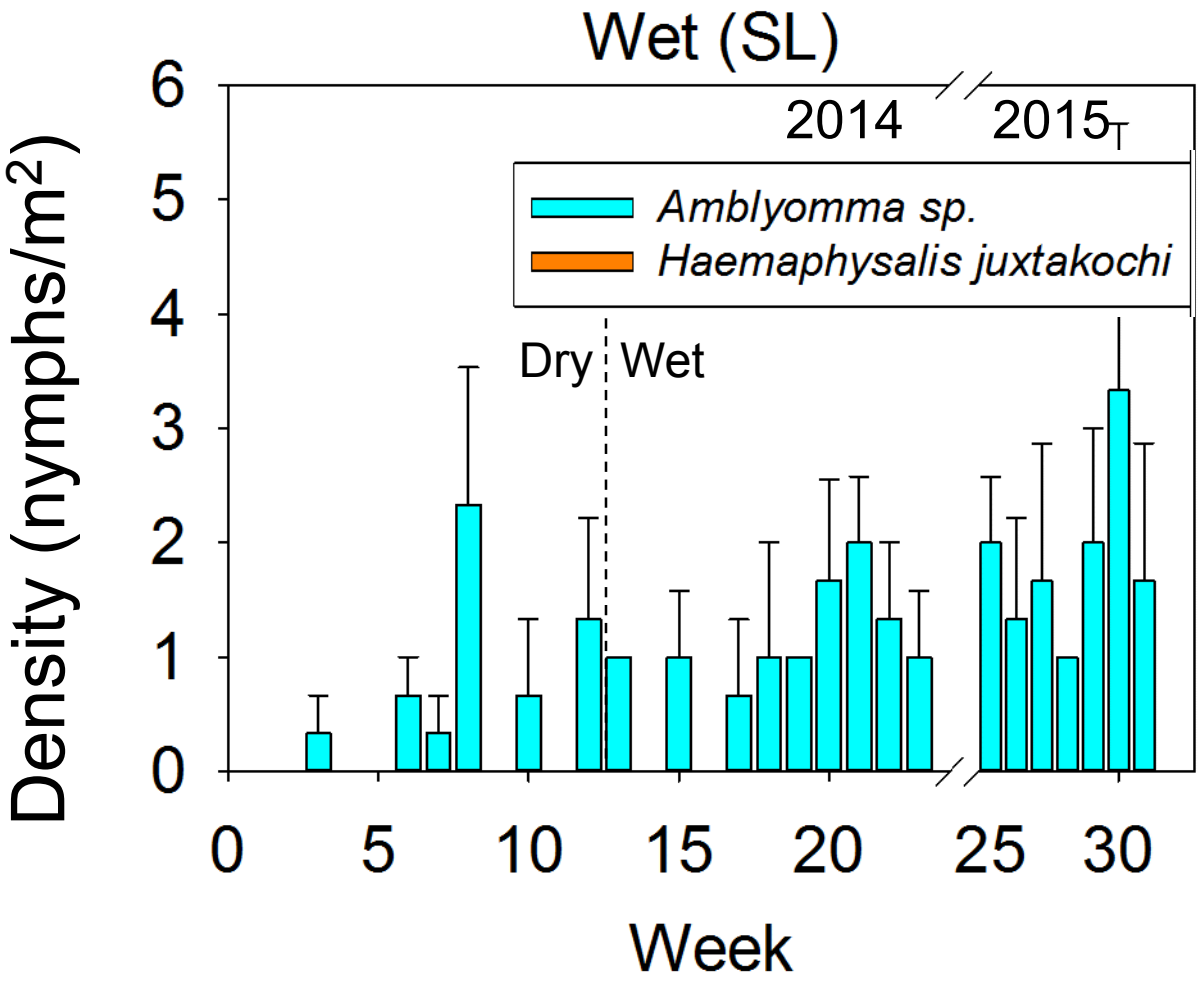
Temporal Variation in Abundance - Dry



Temporal Variation in Abundance - Medium



Temporal Variation in Abundance - Wet

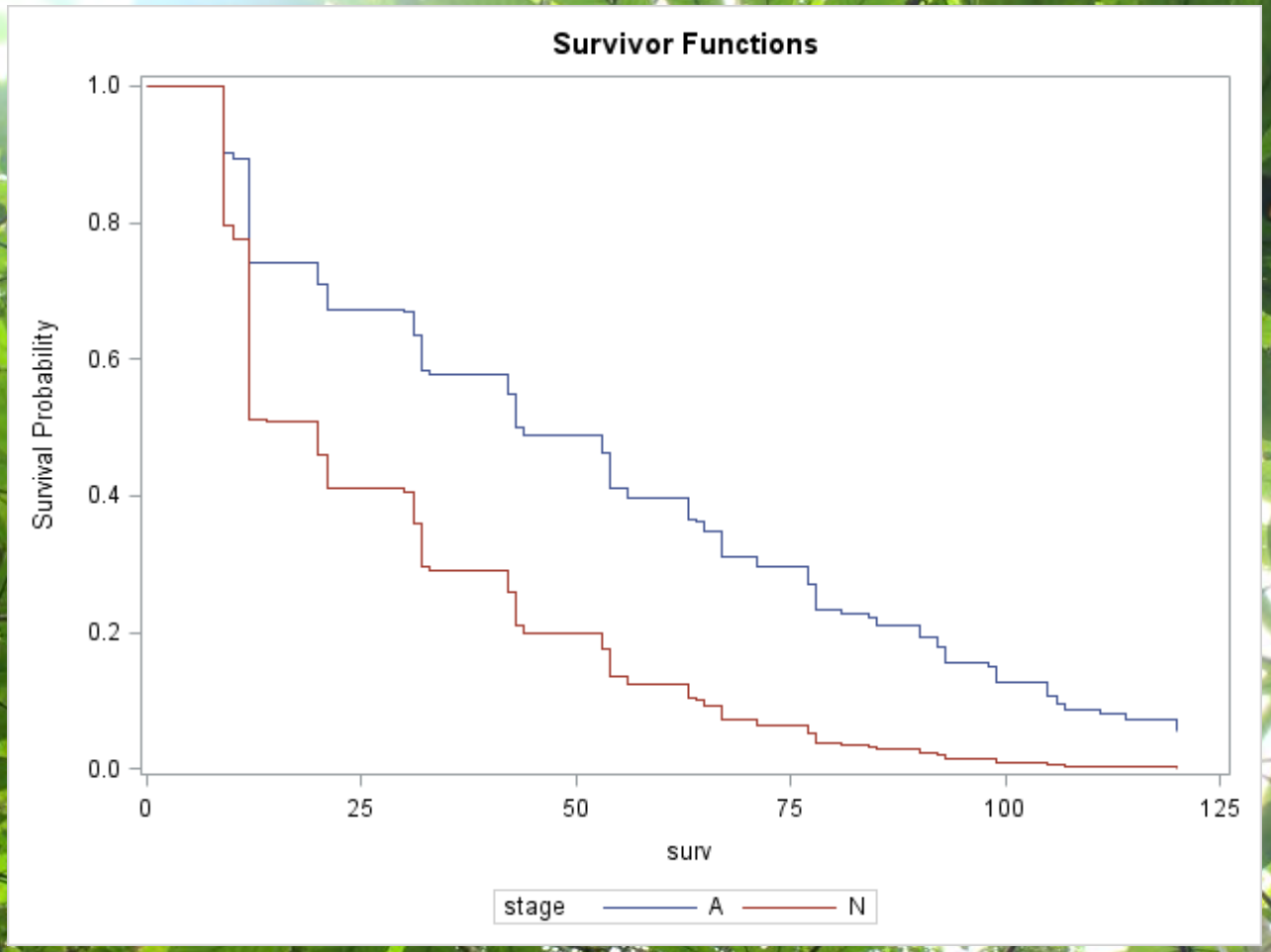


Survival Enclosures

- Measured survival of communities of nymph and adult ticks across isthmus
- Local enclosures
  - Monitored survival weekly
  - Measured temperature and humidity

Photo courtesy of A. Gardner

Nymph vs Adult Survival

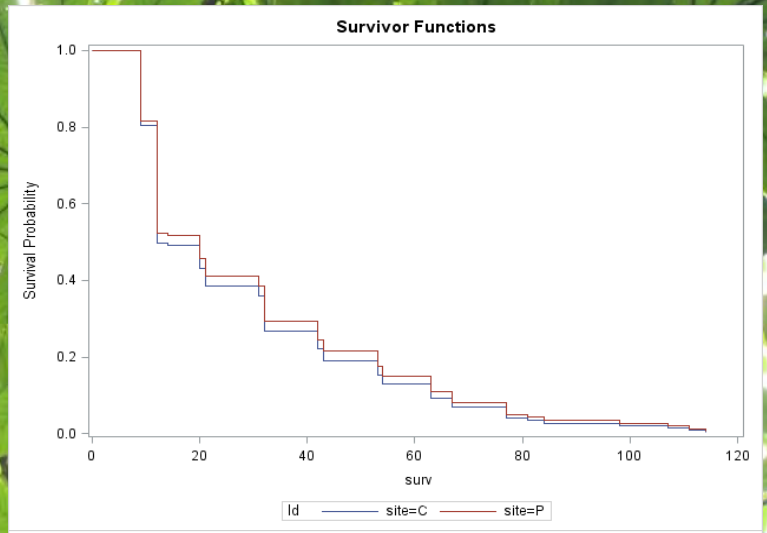


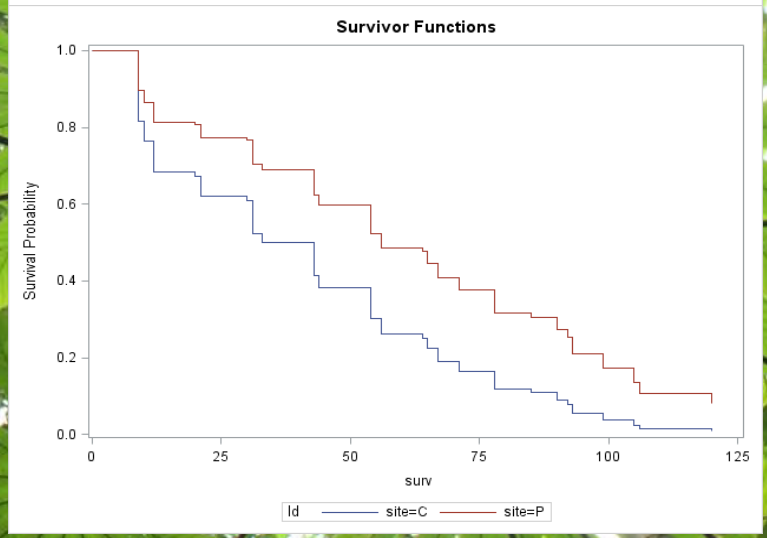
Nymphs experience higher mortality compared to adults

Hazard Ratio=2.257 $p<0.0001$

Survival between sites

- Nymphs
  - No difference
    - p=0.5886
- Adults
  - Higher mortality at dry site
    - p=0.0031
    - Hazard Ratio=1.862



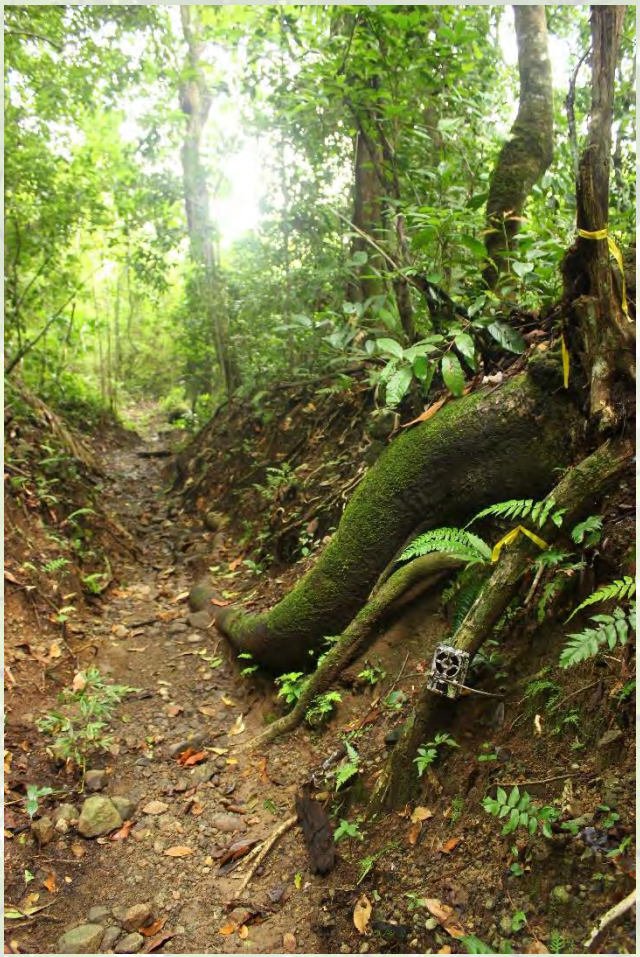


Summary – Abundance & Survival

- Adult and nymph tick abundance at the dry and medium sites were negatively associated with rainfall
- Significantly fewer nymphs at wet site; no difference in larval abundance
  - Suggests something is happening to reduce recruitment
- Nymphs had higher mortality than adults
- Adults at dry site had higher mortality than adults at medium site

Camera Trapping

- Estimate relative abundance of small- to medium-sized terrestrial vertebrates across sites
- Deploy 9 camera traps per site (27 total) in 3x3 grid



Camera Trapping – Preliminary Results

Pathogen Detection

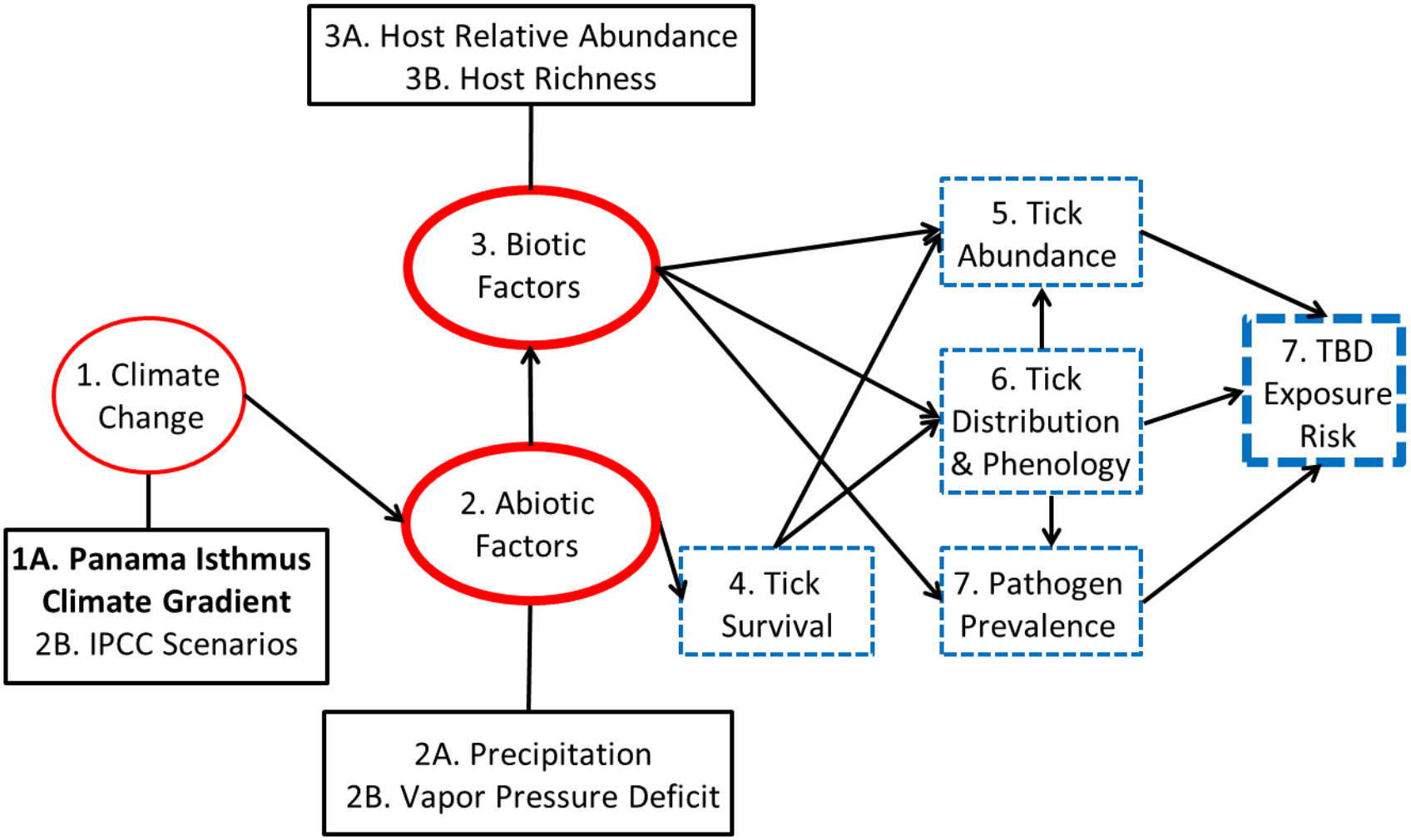
- Pathogens in Panama:
  - *Rickettsia rickettsii* (Spotted Fever Rickettsiosis)
  - Spotted Fever Group Rickettsiae (*R. amblyommii, R. rhipicephali, R. felis, R. parkeri,* others)
  - *Ehrlichia chafeensis* (human ehrlichiosis)
  - *Ehrlichia canis* (canine ehrlichiosis)
  - *Anaplasma marginale* (anaplasmosis)
  - *Anaplasma phagocytophilum* (anaplasmosis)

- Used PCR followed by reverse line blot (RLB) hybridization to screen for pathogen presence
  - Focused on *Rickettsia* and *Ehrlichia*

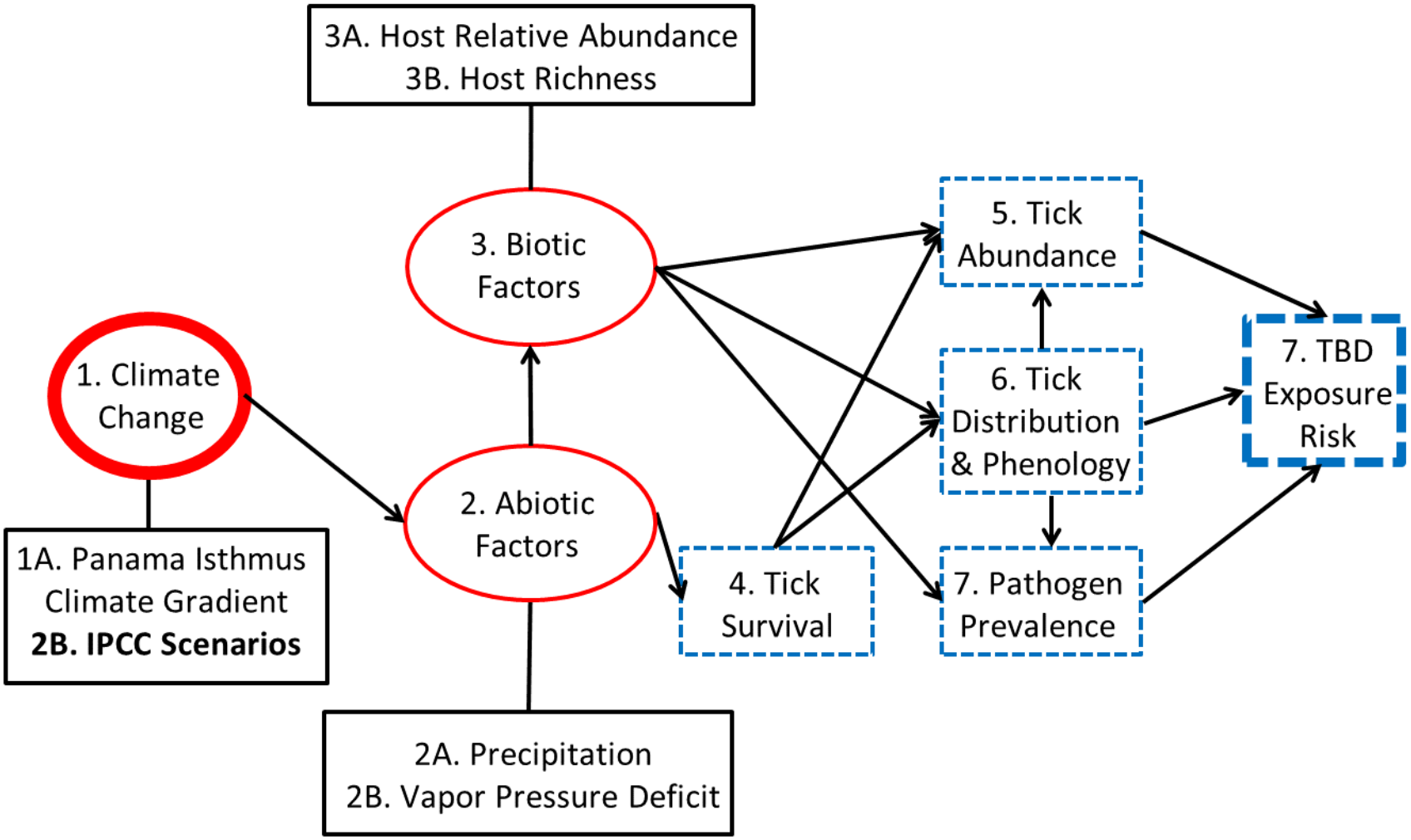
Pathogen Detection – Preliminary Results

- Total of 162 ticks screened (150 *Amblyomma*, 12 *Haemaphysalis*)
  - 31 ticks positive for pathogen presence (19.1%)
  - 20 ticks positive for Spotted Fever Group Rickttsiae (12.3%)
  - 9 ticks positive for *Ehrlichia canis* (5.6%)

Next Steps: Structural Equation Model



Next Steps: Structural Equation Model



Acknowledgments

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